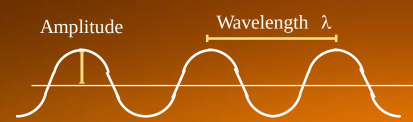
Unit 1
Light

Ch 3.3, 3.4, 3.5,

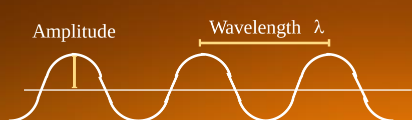
Wave Properties

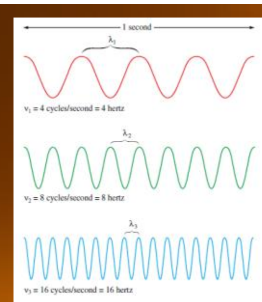
- **Wavelength (λ):**
  - Distance between two subsequent peaks or troughs
  - Often measured in meters or nanometers



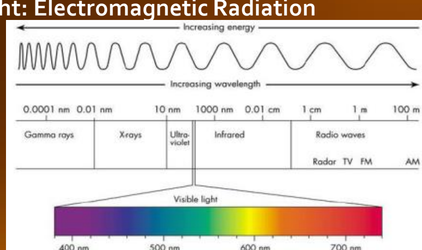
Wave Properties

- **Frequency (ν):**
  - The number of complete wavelengths that pass a given point in 1 second
  - **Measured in Hertz (1 Hz = 1 cycle per second), 1/s or s^{-1}**





Light: Electromagnetic Radiation



Relationship between λ and ν

- An important property of a wave is its speed:

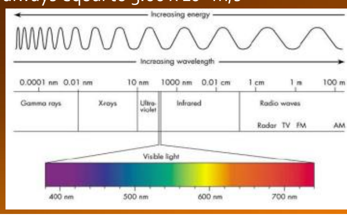
Speed = Wavelength **x** Frequency

c = λ ν

- The speed of all electromagnetic radiation is the speed of light **(c) = 2.998 x 10^8 m/s**
- Wavelength is often measured in nanometers so be careful with your units when solving these problems

Frequency/Wavelength Relationship

Inverse Relationship: If one increases then the other must decrease so that their product is always equal to 3.00 x 10^8 m/s



Practice 1

1. The red light given off by a neon lamp has a wavelength of 470 nm. What is the frequency of this radiation?

- $\nu = 6.4 \times 10^{14}\ s^{-1}$

2. A wave has a frequency of 90.1 MHz. Calculate the wavelength. What type of electromagnetic radiation is this?

- 3.33 m, radio wave (FM)

Planck's Quantum Theory

- Proposed that atoms and molecules emit (or absorb) energy only in discrete quantities quanta/quantum
- Planck proposed that the energy of a quantum is related to its frequency by the following equation:

E = h ν

E = energy (Joules)
h = Planck's constant (6.626×10^{-34} J s)
ν = frequency (Hz = 1/s = s^{-1})

Practice 2

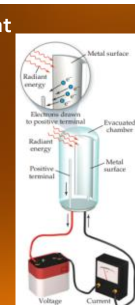
1. Calculate the energy of one photon of red light that has a wavelength of 470 nm.
   4.2×10^{-19} J
2. Calculate the energy of one mole of these photons.
   2.5×10^{5} J/mol

Wave Particle Duality of Light

- **Planck**'s idea that energy is transmitted in bundles (or packets) much like a particle (Classical physics assumed that energy always behaved as a wave)
- **Einstein** explained the photoelectric effect using Planck's theory

Wave Particle Duality of Light

- **Photoelectric effect:** electrons are ejected from the surface of certain metals exposed to light of at least a certain minimum frequency called the threshold frequency
- Suggested that a beam of light is really a stream of particles called **photons**



▲ FIGURE 6.7 The photoelectric effect.

Wave Particle Duality of Light

- So….light behaves <u>both</u> as a wave and as a particle